Small Business Innovation Research/Small Business Tech Transfer

Deep Learning Applied to Detecting Salient Features and Building Better 3D Models, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

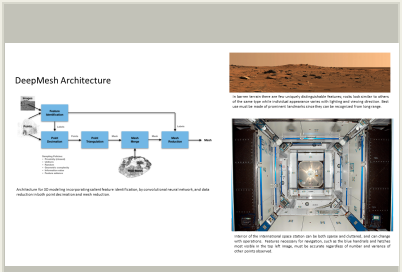
We propose to develop a method to effectively utilize the massive amount of image and range data that cameras and laser scanners can generate for an autonomous navigation system. **Our innovative approach is to use deep learning to detect and segment only the most useful portions of the data and to use that to build better 3D models.** We have proven methods for building accurate 3D models of the environment for robotic systems. [Wettergreen12] This new work will enable us to create better 3D models by identifying and incorporating the most salient information. These models will be more sparse but will have higher information content. This will improve ease of communication and quality of action planning.

In Phase 1 we will prove the underlying concepts (use of salient features, segmentation by learning, efficient 3D modeling) in the context of one test environment. We will evaluate methods for determining the importance of object characteristics in their overall quality as a landmark. We will demonstrate improved landmark detection and selection in rocky and natural terrain. In Phase 2 we will generalize the work, considering several policies for salience and will implement system and test in multiple environments. We will demonstrate system learning over time and detecting new and reliable landmarks. Evaluate and demonstrate selective downlink methods that allow for offline training while also returning science-relevant data.

Anticipated Benefits

This work benefits NASA by advancing solutions to challenges identified in the 2015 NASA Technology Roadmap: **TA4 Robotics and Autonomous Systems**, specifically **TA4.1 Sensing and Perception** and **TA4.2 Mobility**, as they both relate to modeling the environment in three-dimensions. The proposed research and development will provide maps (3D models) for surface and above-surface mobility and manipulation. Our innovation will reduce requirements for onboard memory and computing power.

The challenges of modeling the environment confront almost every industrial and commercial application. In natural environments such as agriculture, forestry or undersea, where both vast scale and minute detail are important, accurate 3D models lead to efficient navigation and interaction. The same benefits will be realized in artificial environments indoors, such as in factories and warehouses, and outdoors as in mine and construction sites.



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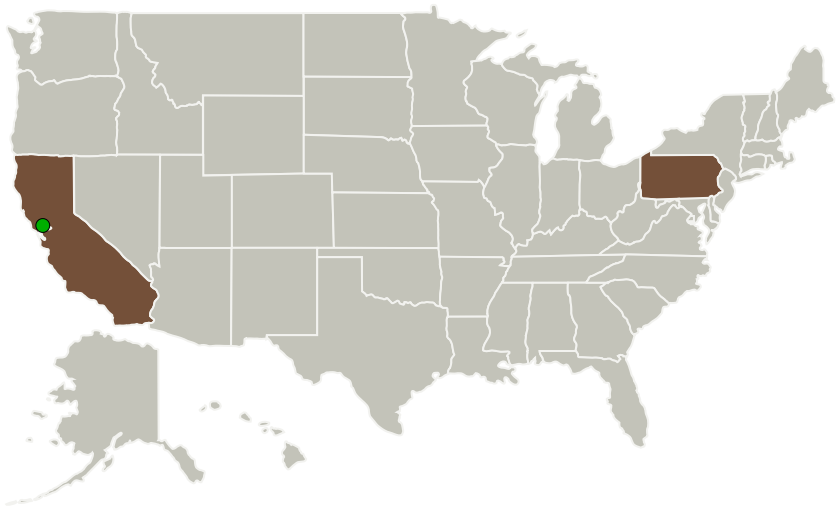
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Mesh Robotics, LLC	Lead Organization	Industry	Pittsburgh, Pennsylvania
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California
Carnegie Mellon University	Supporting Organization	Academia	Pittsburgh, Pennsylvania

Primary U.S. Work Locations	
California	Pennsylvania

Project Transitions

July 2018: Project Start

August 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141323)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Mesh Robotics, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

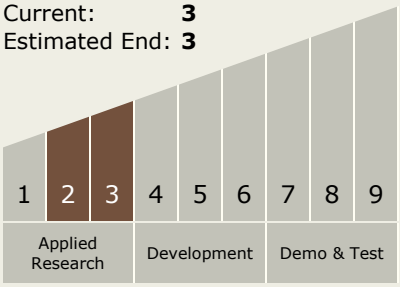
Carlos Torrez

Principal Investigator:

David Wettergreen

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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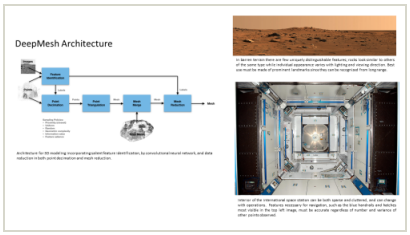
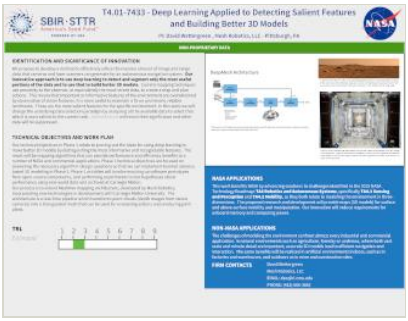
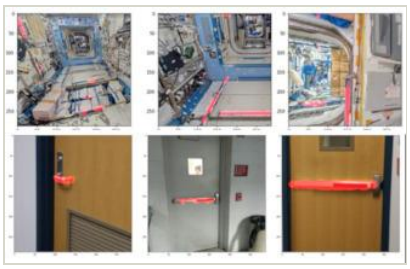
Images



Briefing Chart Image
Deep Learning Applied to Detecting Salient Features and Building Better 3D Models, Phase I
(https://techport.nasa.gov/image/136290)



Final Summary Chart Image
Deep Learning Applied to Detecting Salient Features and Building Better 3D Models, Phase I
(https://techport.nasa.gov/image/133897)



Final Summary Chart Image
Deep Learning Applied to Detecting Salient Features and Building Better 3D Models, Phase I
(https://techport.nasa.gov/image/133629)

Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.2 Mobility
    - TX04.2.4 Surface Mobility

Target Destinations

Earth, The Moon, Mars